CalNex 2010: Plans for a Climate Change and Air Quality Field Study in California

DAVID PARRISH

NOAA/ESRL

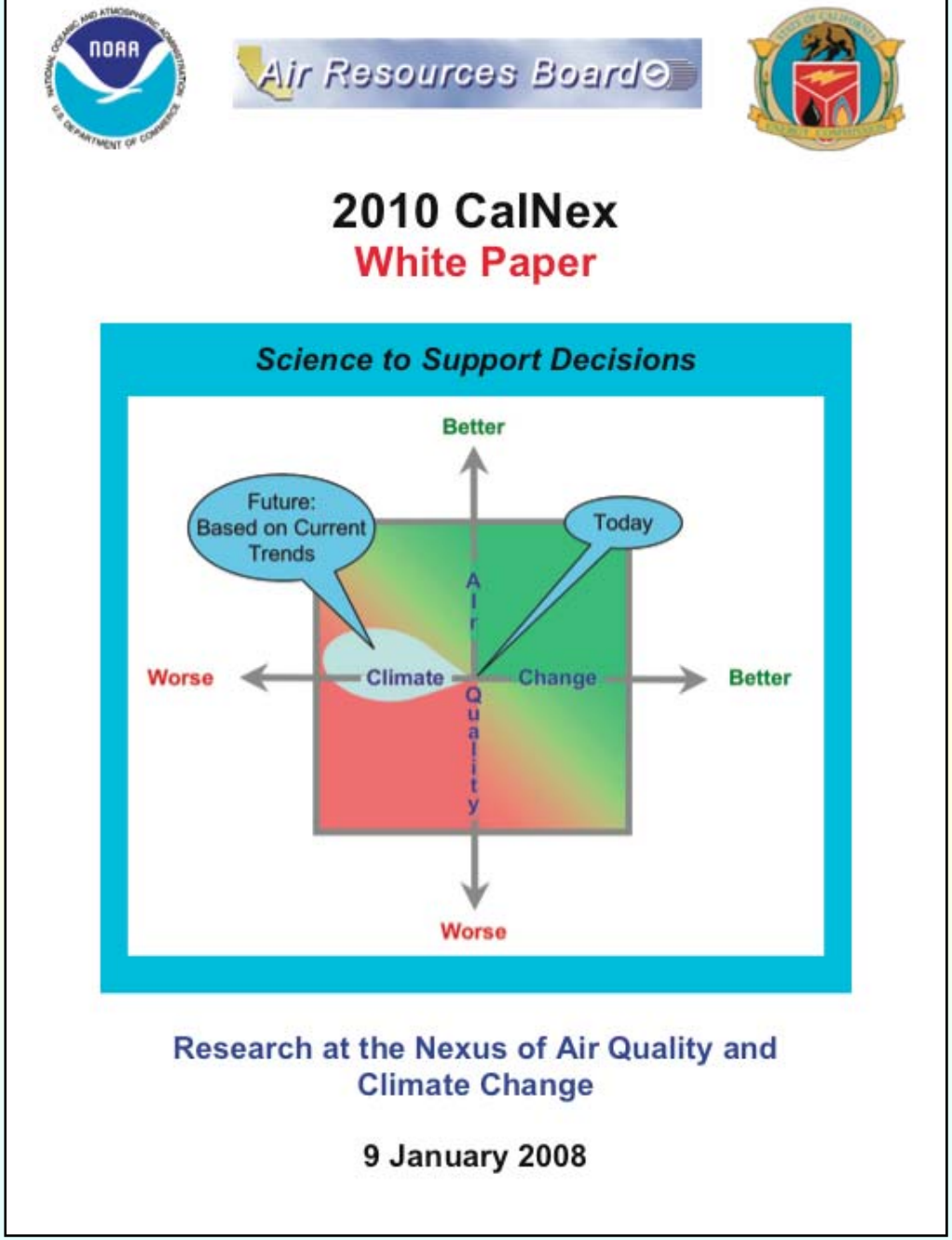
Chemical Sciences Division

Organized by

NOAA/CARB/CEC

(CARB: $2M in 2008/09)

5th Annual
California Climate Change Conference
September 8-10, 2008, Sacramento, CA



http://www.arb.ca.gov/research/fieldstudy2010/fieldstudy2010.htm

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Summer

CalWater 2009/10: Energy, Water and Regional Climate

Winter/Summer

Complementary foci
NOAA involved in both

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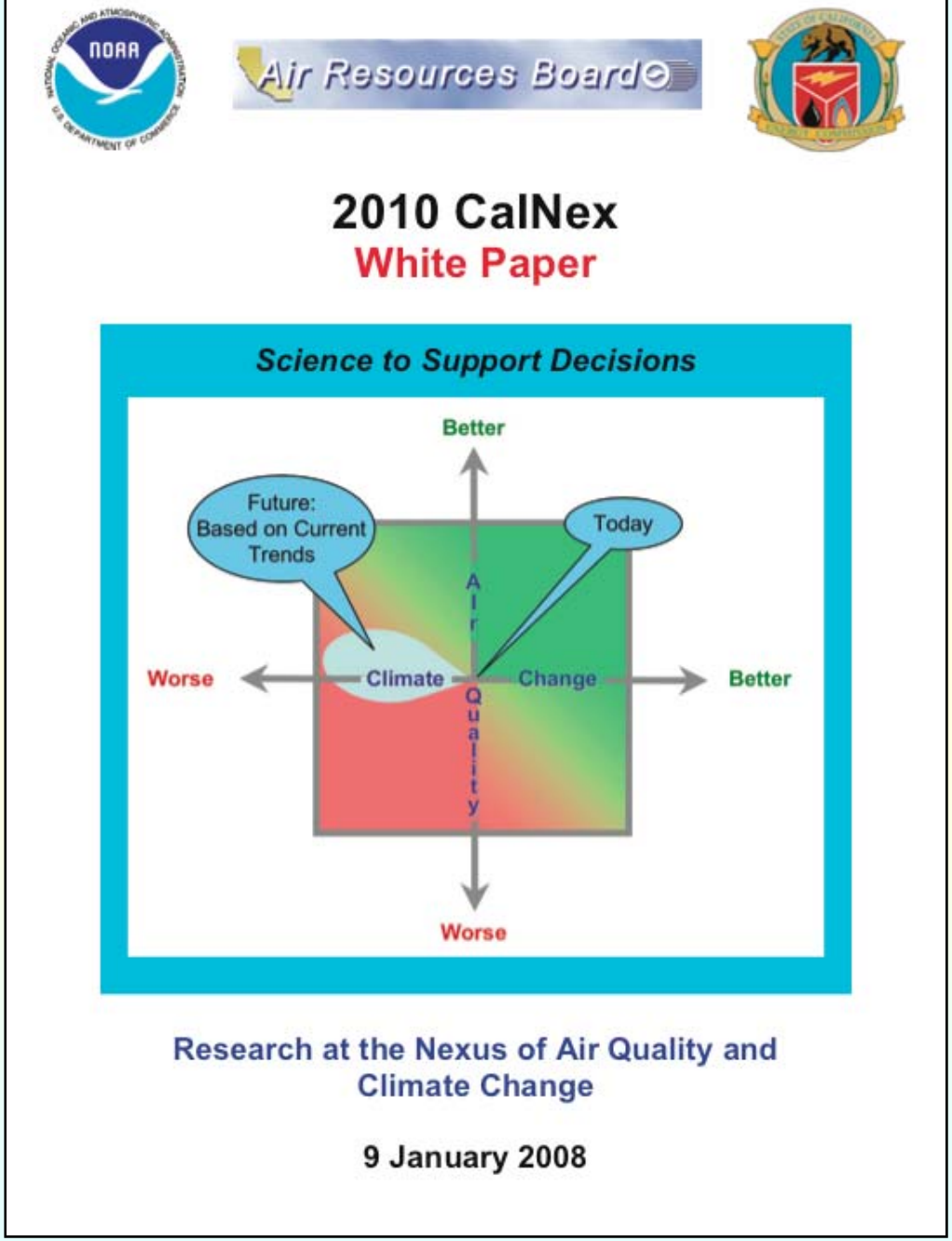

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CalNex 2010: Plans for a Climate Change and Air Quality Field Study in California

today:

- Introduction to CalNex 2010
- Introduction to NOAA's interests and platforms
- Science issues: focus on Climate Change

Why CalNex?

5th Annual
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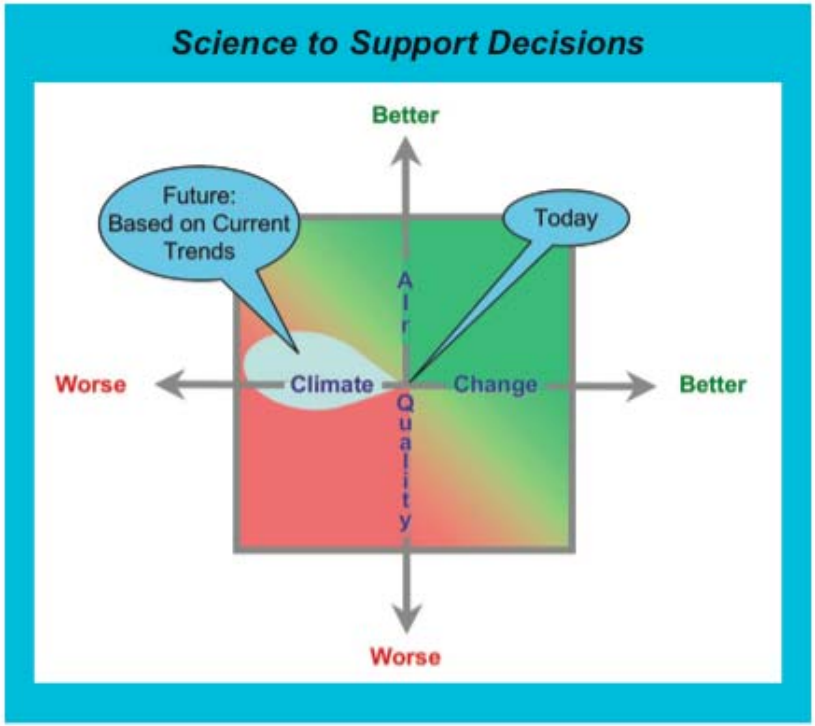
2010 CalNex
White Paper



Research at the Nexus of Air Quality and Climate Change

9 January 2008

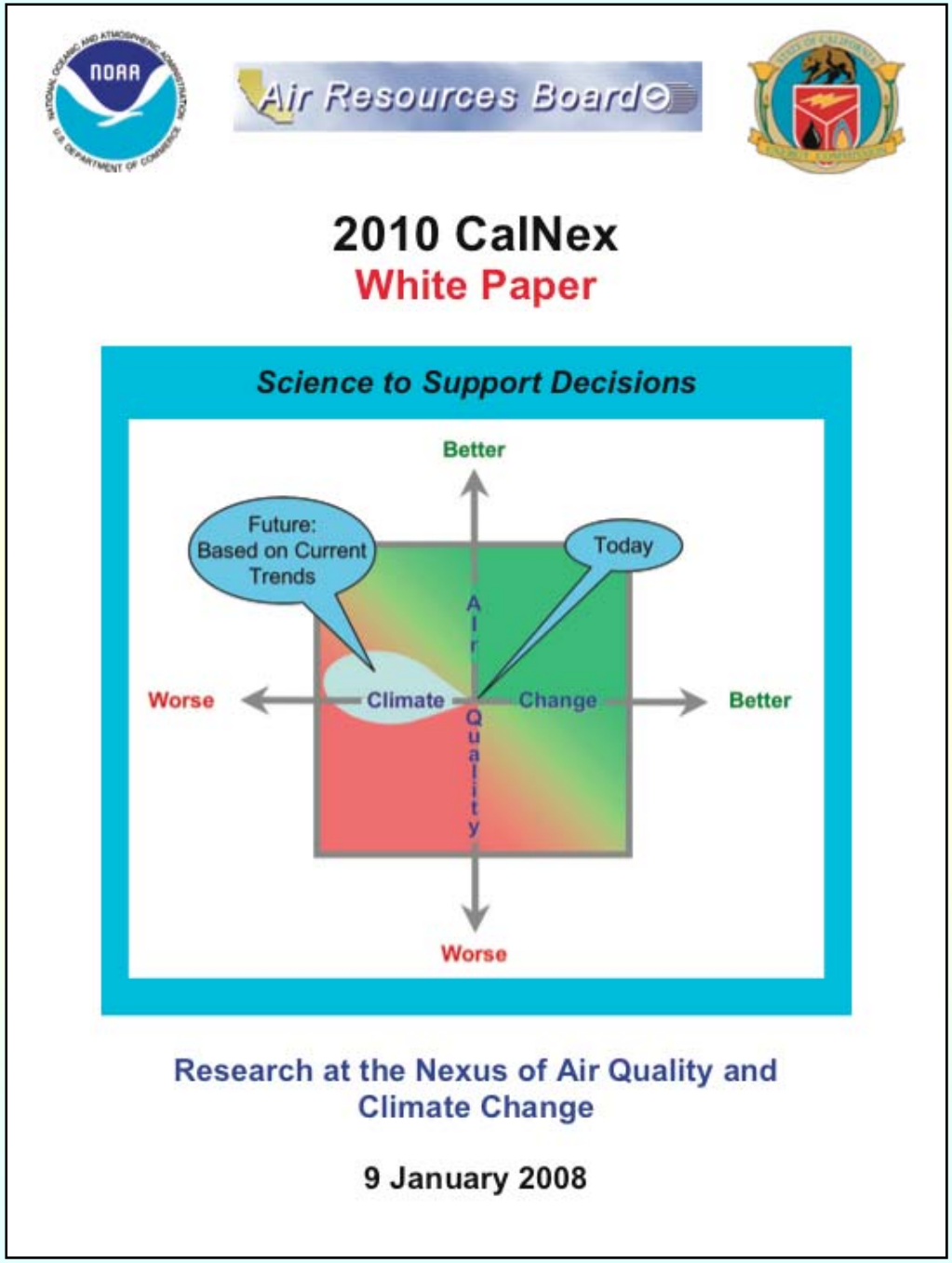
http://www.arb.ca.gov/research/fieldstudy2010/fieldstudy2010.htm

CalNex 2010: Plans for a Climate Change and Air Quality Field Study in California

1) Management and Mitigation Strategies for these 2 issues are strongly linked.

2) Sources and Processes for these 2 issues are the same (nearly).

Why California?



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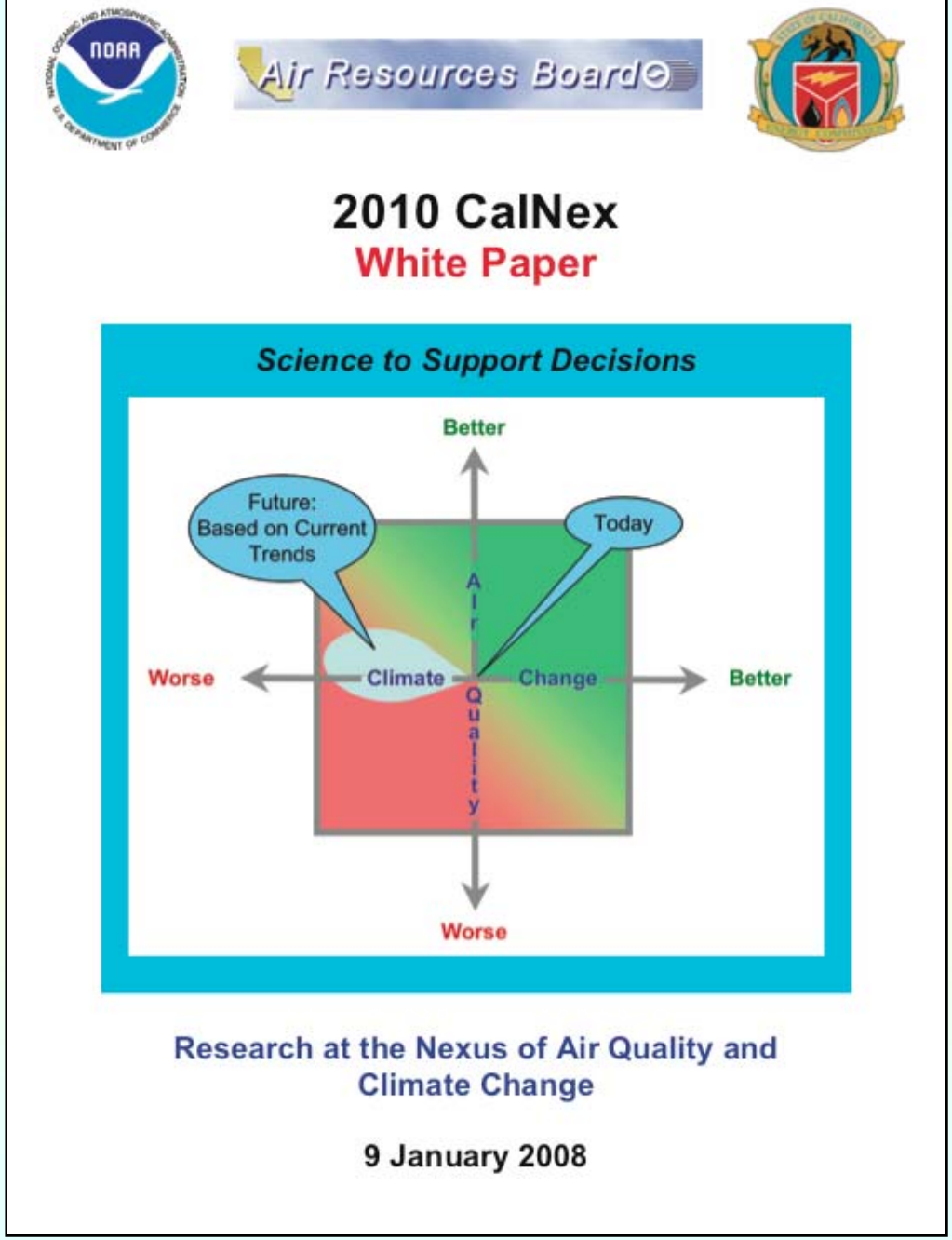
Study Rationale

- *California has traditionally led the nation in addressing Air Quality issues.*
- *California has recently taken the lead in beginning to address Climate Change.*
- *NOAA is developing a new research initiative addressing Air Quality and Climate Change linkages.*

CalNex addresses NOAA's and California's Science Interests

What are NOAA's interests?



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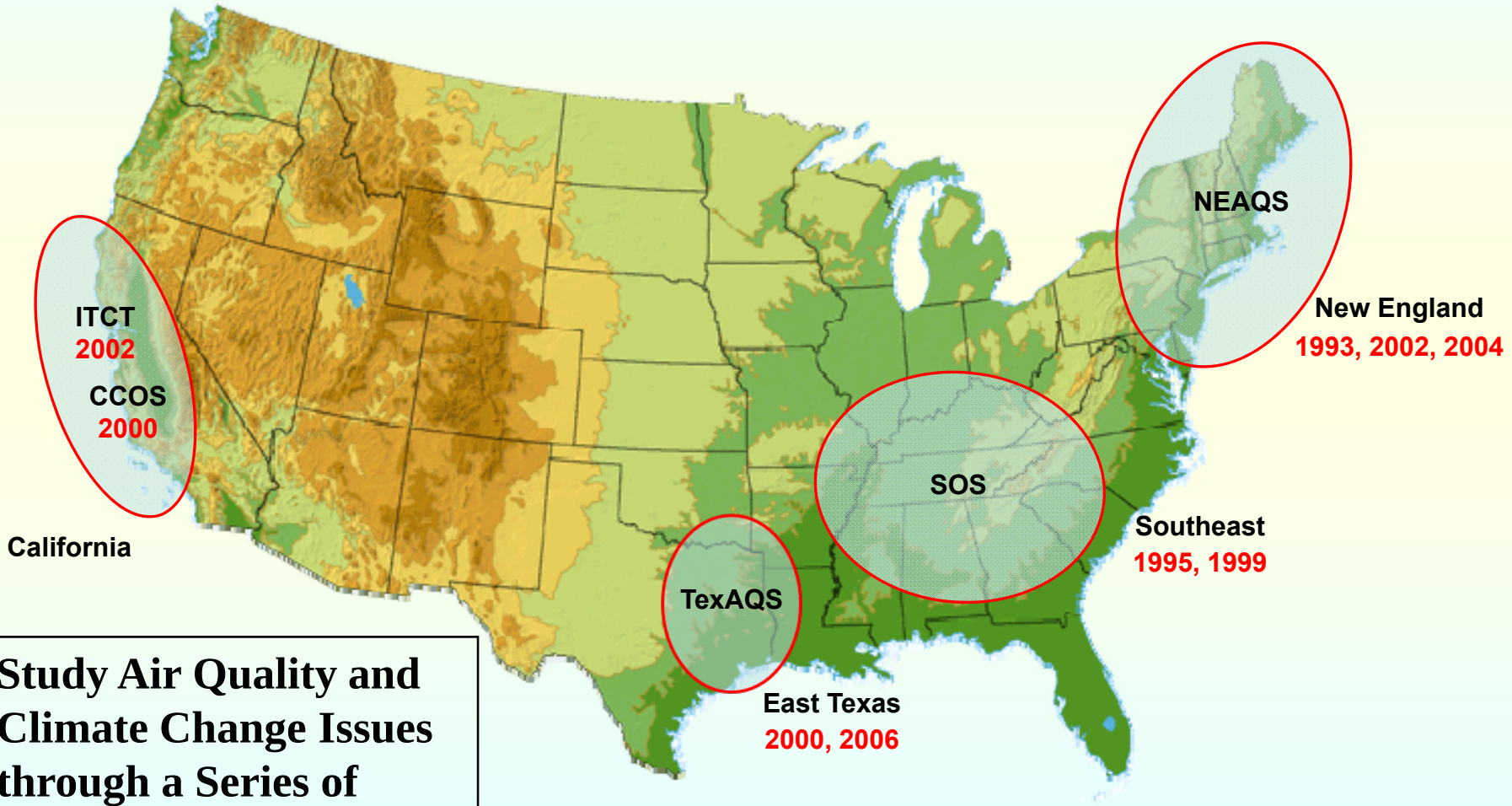
NOAA/ESRL Regional Intensives

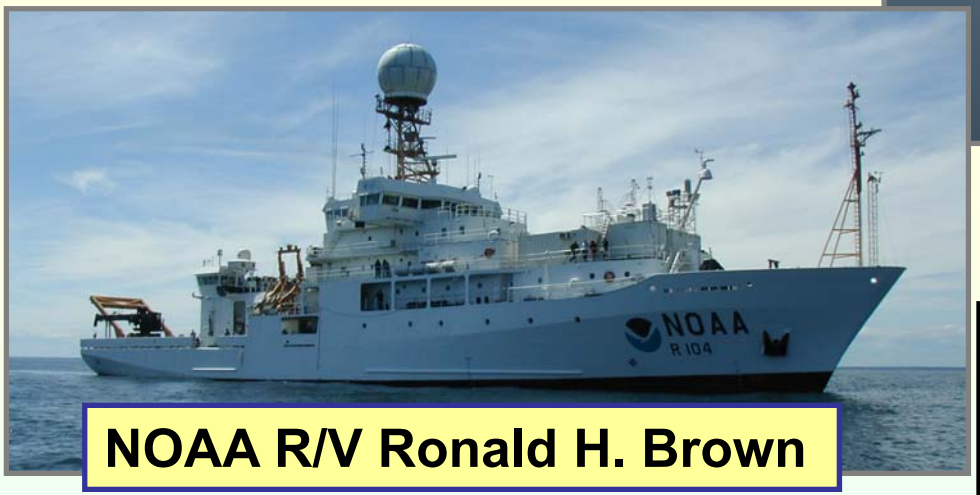
Chemically and Meteorologically Diverse

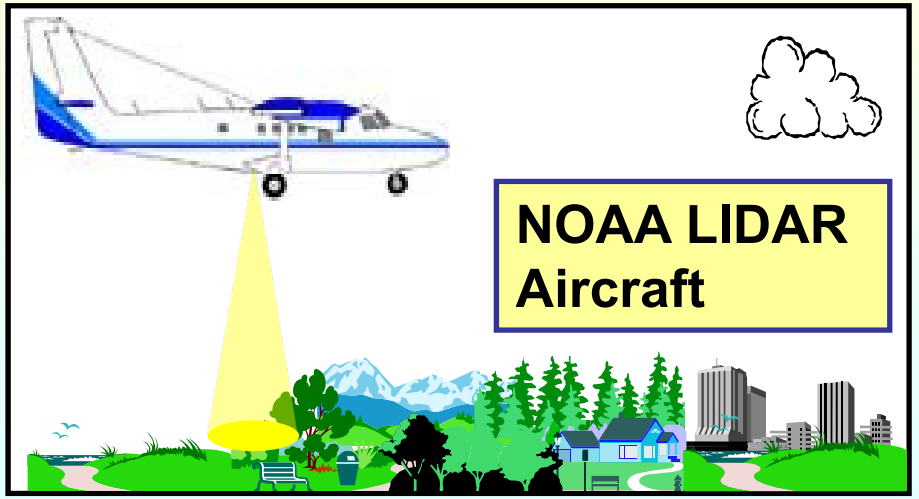


Study Air Quality and Climate Change Issues through a Series of Regional Intensives

What does NOAA contribute?

NOAA's Assets





Collaborate with Others on fielding Ground-based Remote and In Situ Instrumentation

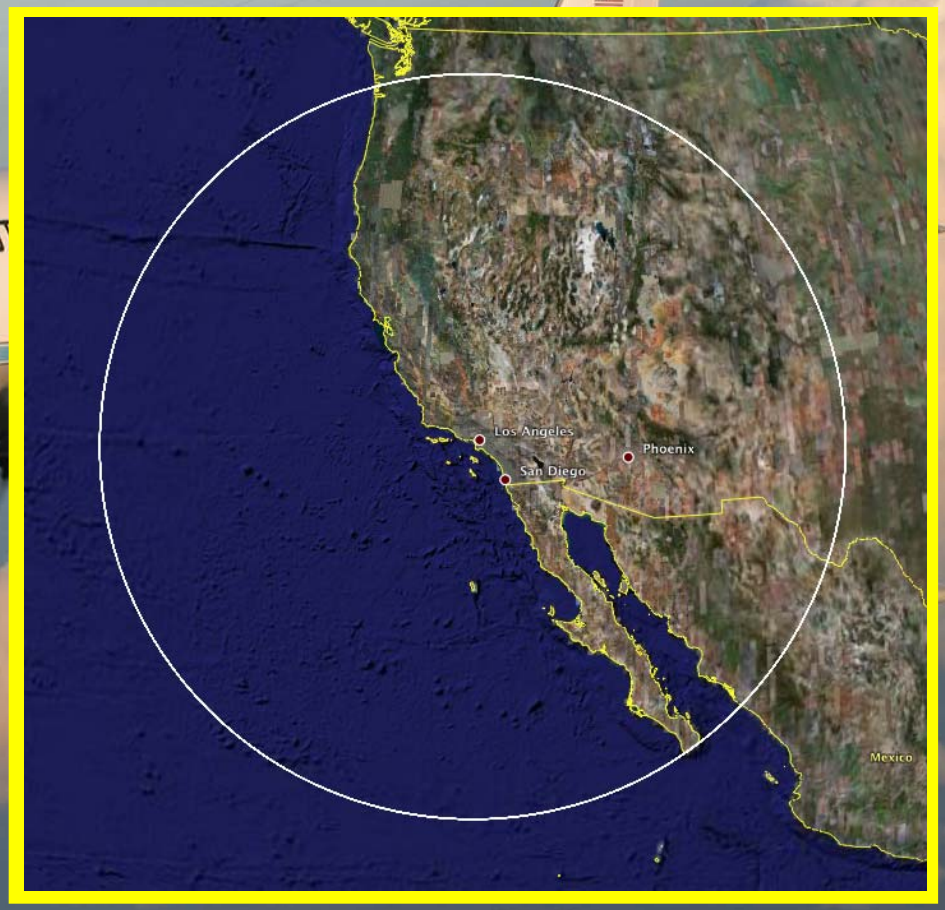
NOAA WP-3D Research Aircraft

Specifications

- Airspeed: ~ 200 nm/hr
- Endurance: ~ 6-8 hours
- Range: ~ 1200 nm
- Ceiling: ~ 21,000 feet
- Day and night flights
- 5 Scientists

In situ measurements - 1 second averages

- Anthropogenic and natural emissions
- Ozone and other photochemical products
- Aerosols – physical, chemical and optical properties
- Greenhouse gases
- Cloud properties



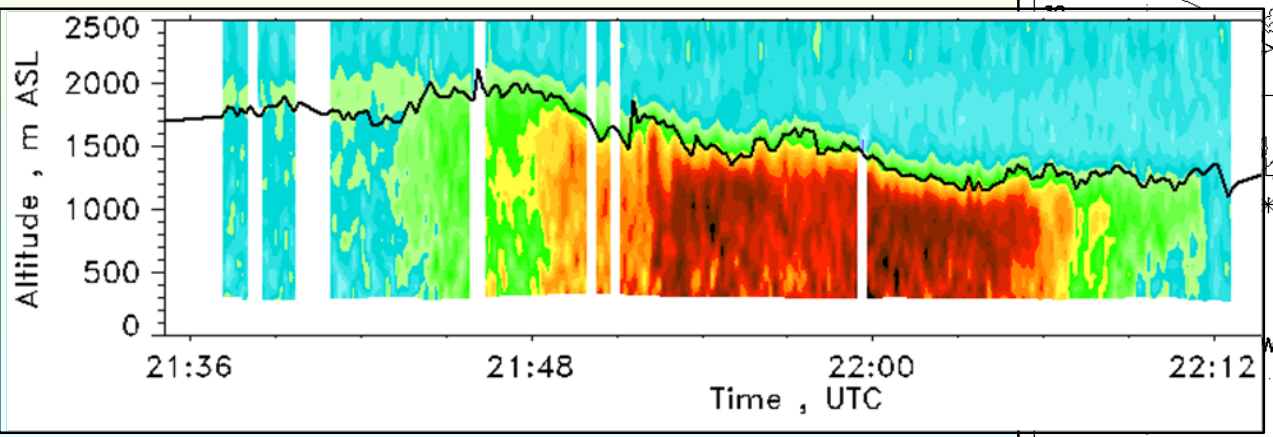
NOAA DeHavilland Twin Otter

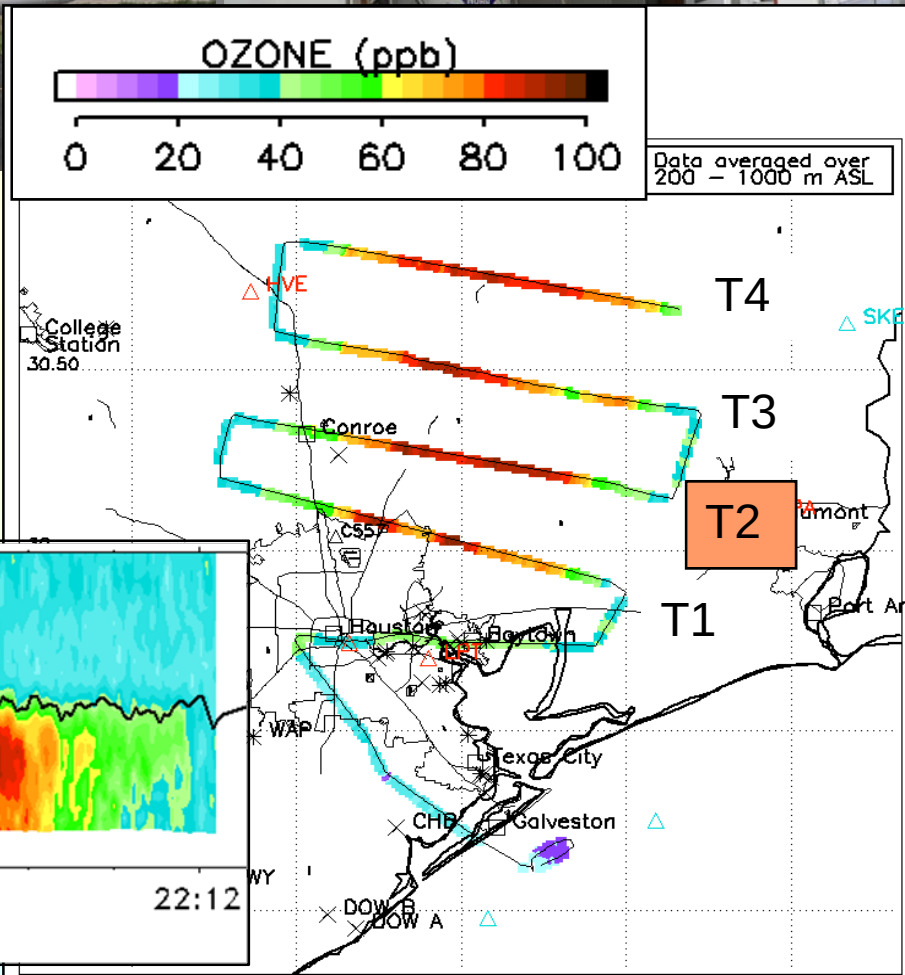
NOAA LIDAR Aircraft

Regional distribution of O_3 and aerosols

Regional and inter-regional transport

Boundary layer evolution and variability.





NOAA Research Vessel Ronald H. Brown

In situ and remote measurements

- **Investigate marine chemistry**
- **Marine and coastal emissions**
- **Land/sea breeze recirculation**
- **Aerosols – physical, chemical and optical properties**
- **Radiation measurements**
- **Aerosol-Cloud interactions**

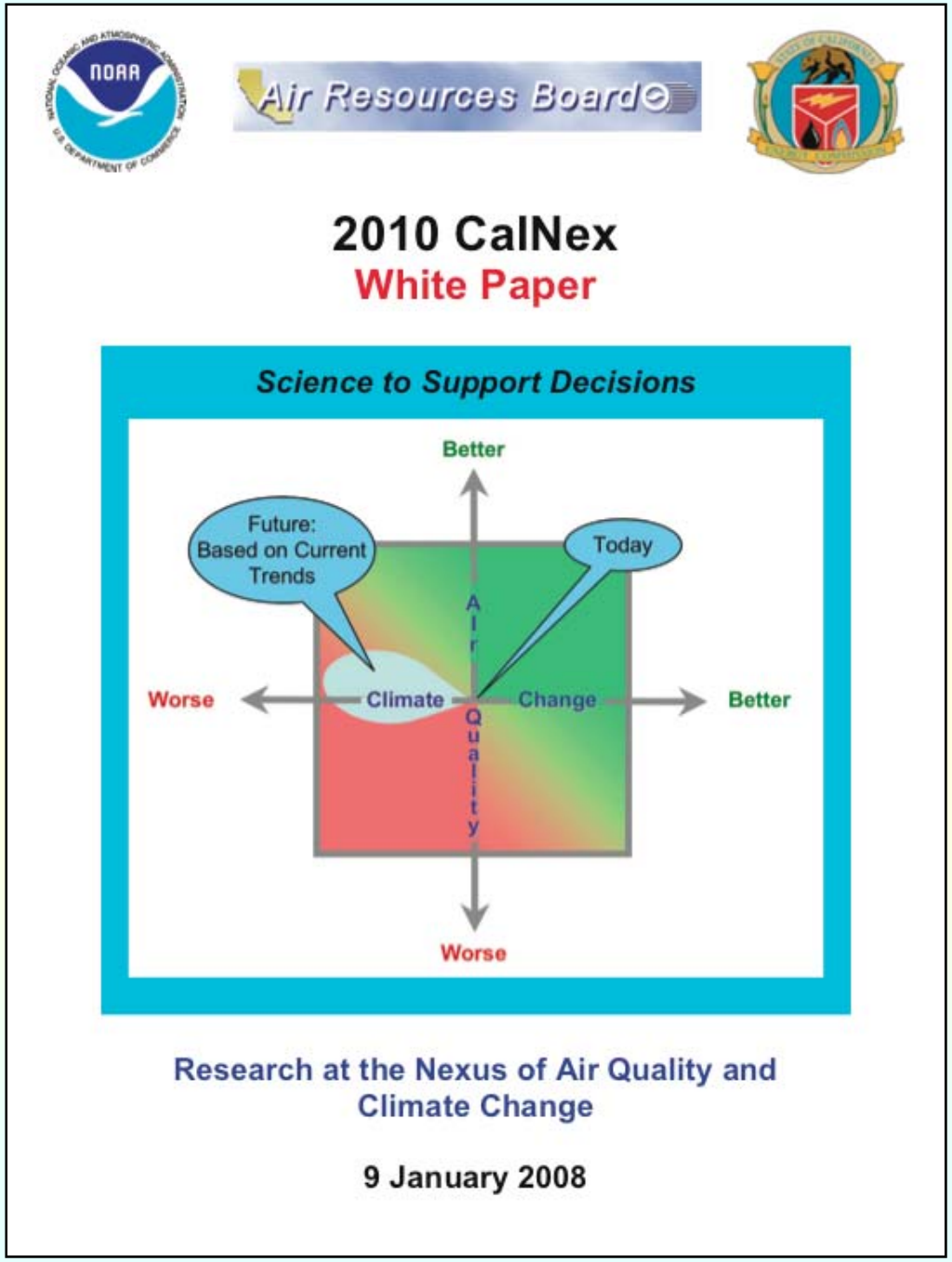
2010 CalNex

California Air Quality & Climate Change Field Study

Science Issues

- *Emissions - top down tests*
- *Chemical Transformation and Climate Processes*
- *Transport and Meteorology*
- *Aerosol Properties and Radiative effects*

4 Example Studies



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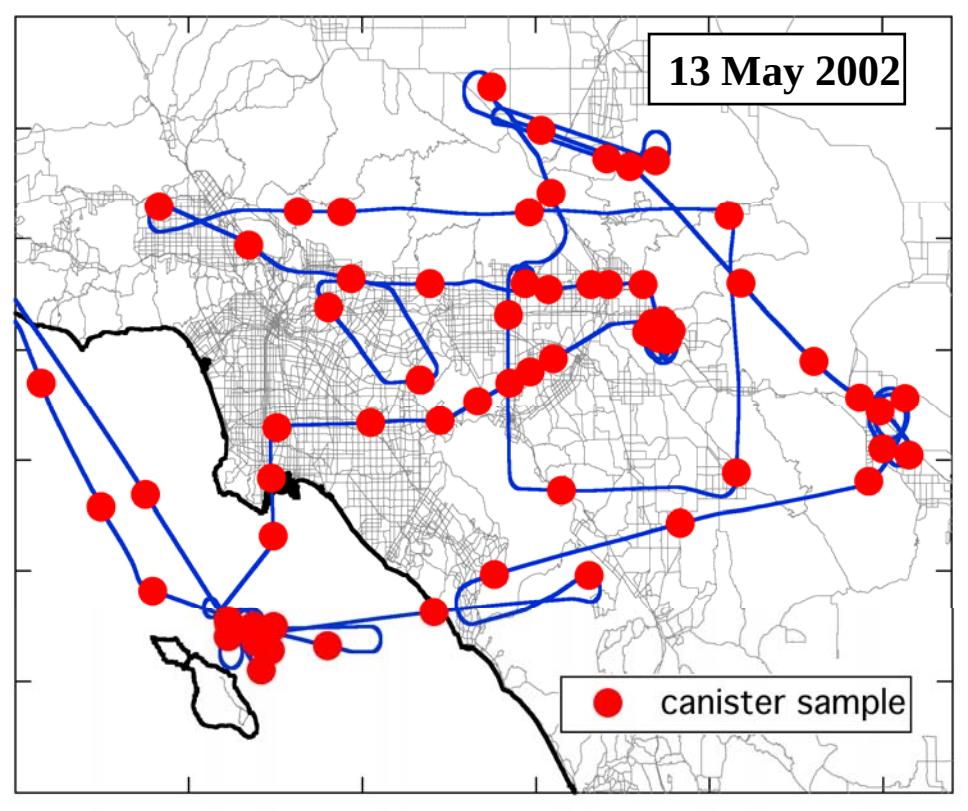
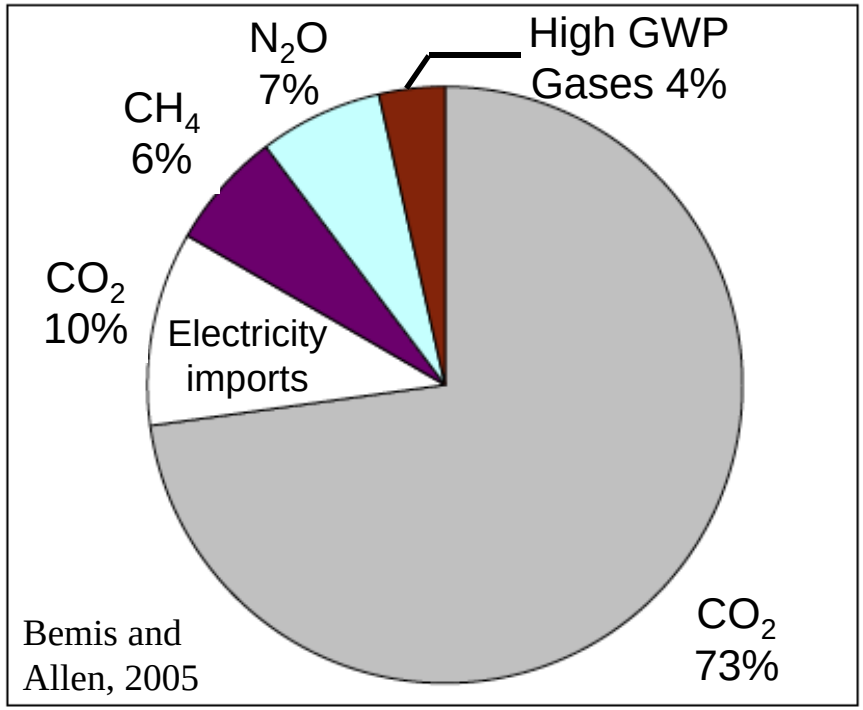
Emissions Quantification

Improved inventories are essential for predictive capability

Non-CO_2 Greenhouse Gas Emissions

- What can measurements tell us?





California greenhouse gas emissions

Global warming potential of greenhouse gases.

Gas	GWP	MW
CO_2	1	44
CH_4	23	16
HFC-134a	1300	102

Emissions Quantification

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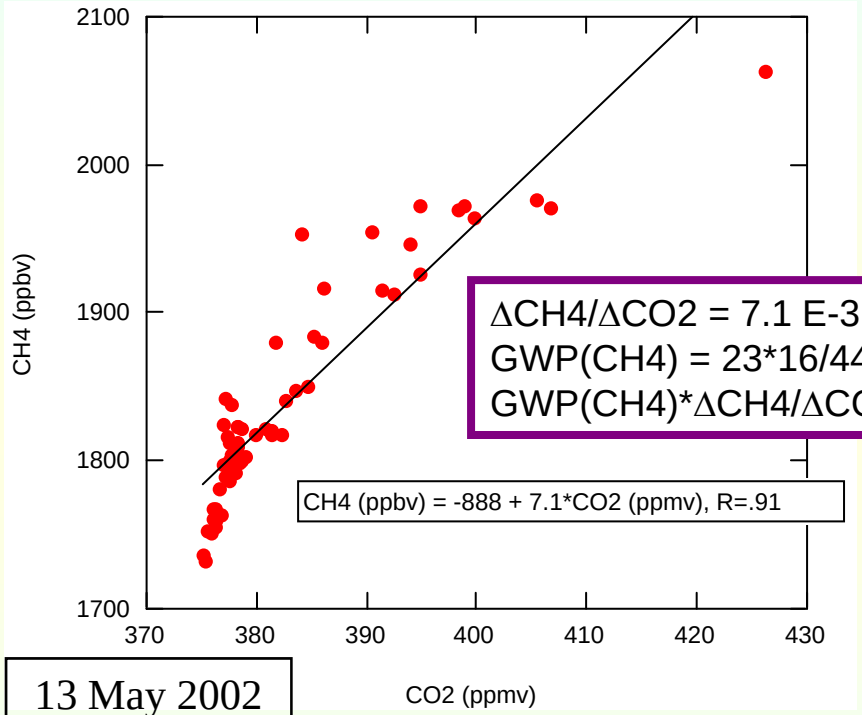
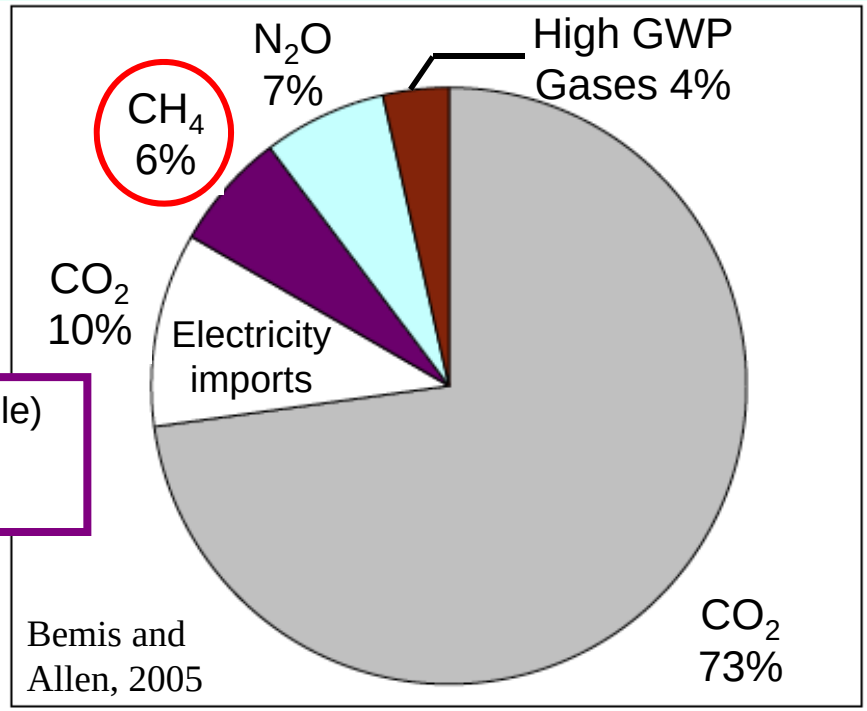


ΔCH4/ΔCO2 = 7.1 E-3 (mole/mole)
GWP(CH4) = 23*16/44
GWP(CH4)*ΔCH4/ΔCO2 = 0.06

13 May 2002
WP-3D flight
Los Angeles



California greenhouse gas emissions

2010: Provide more extensive data set

- **Spatial variability**
- **Agricultural contribution**

Analysis by M. Trainer

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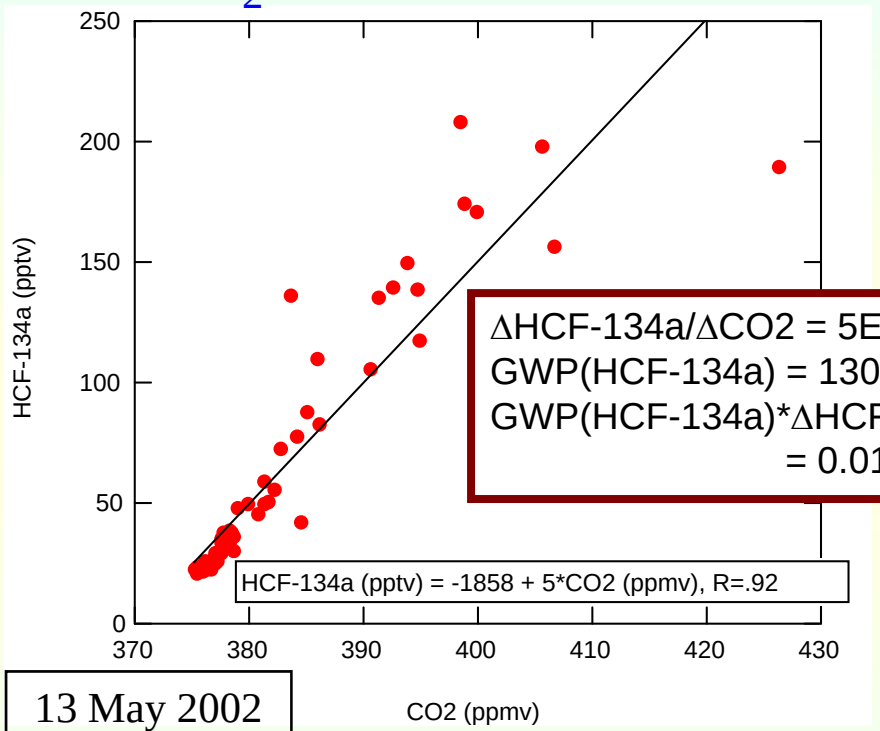
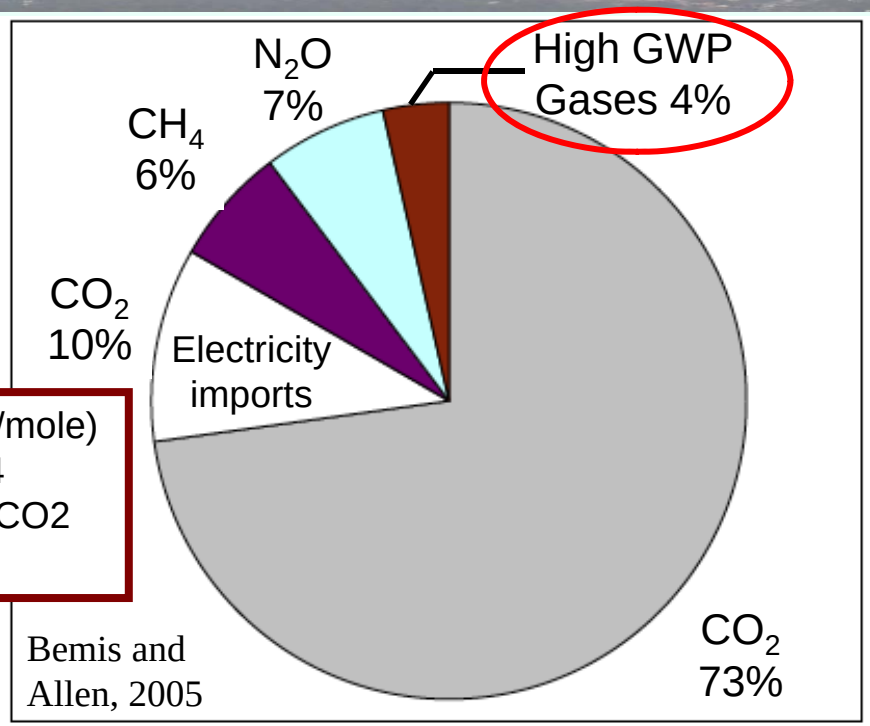


ΔHCF-134a/ΔCO2 = 5E-6 (mole/mole)
GWP(HCF-134a) = 1300*102/44
GWP(HCF-134a)*ΔHCF-134a/ΔCO2 = 0.015

13 May 2002
WP-3D flight
Los Angeles



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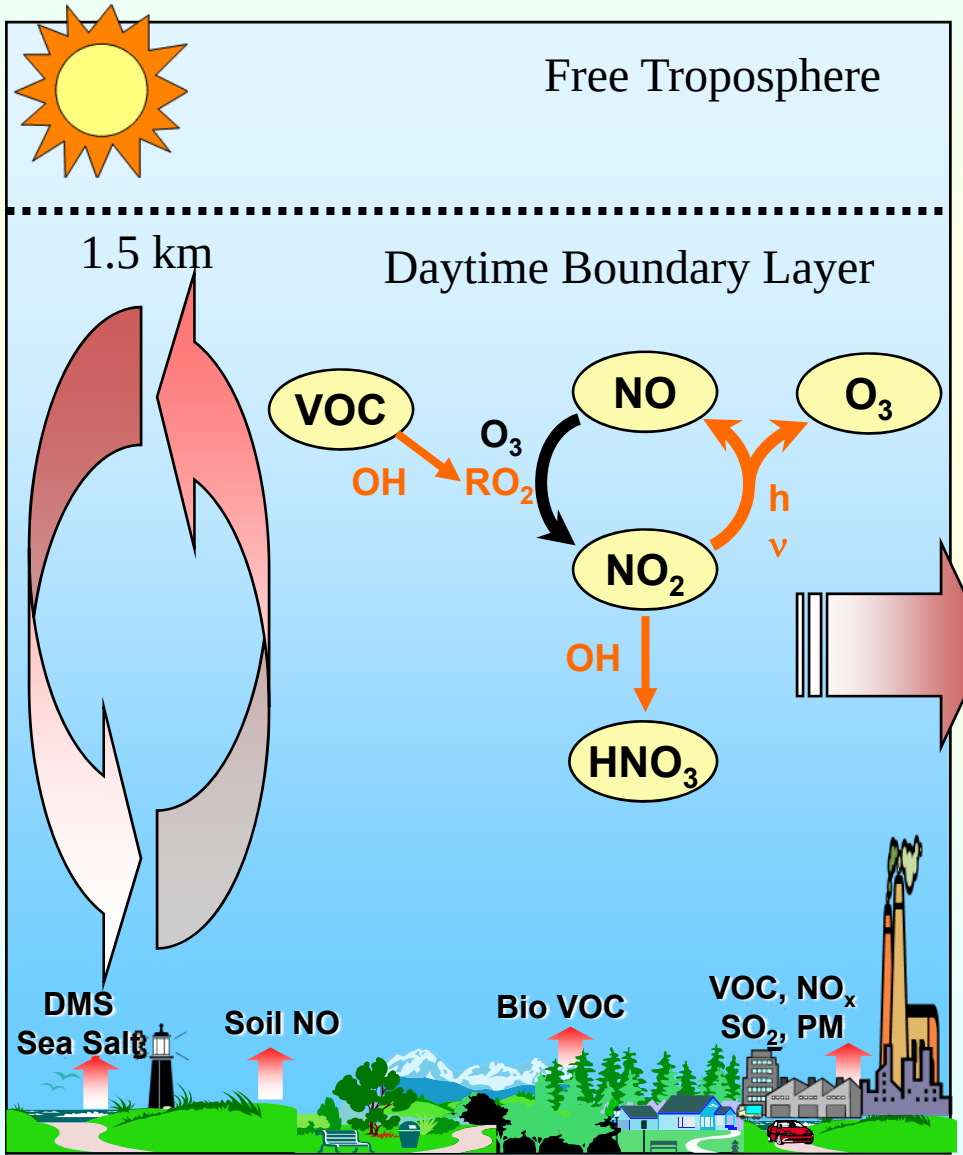
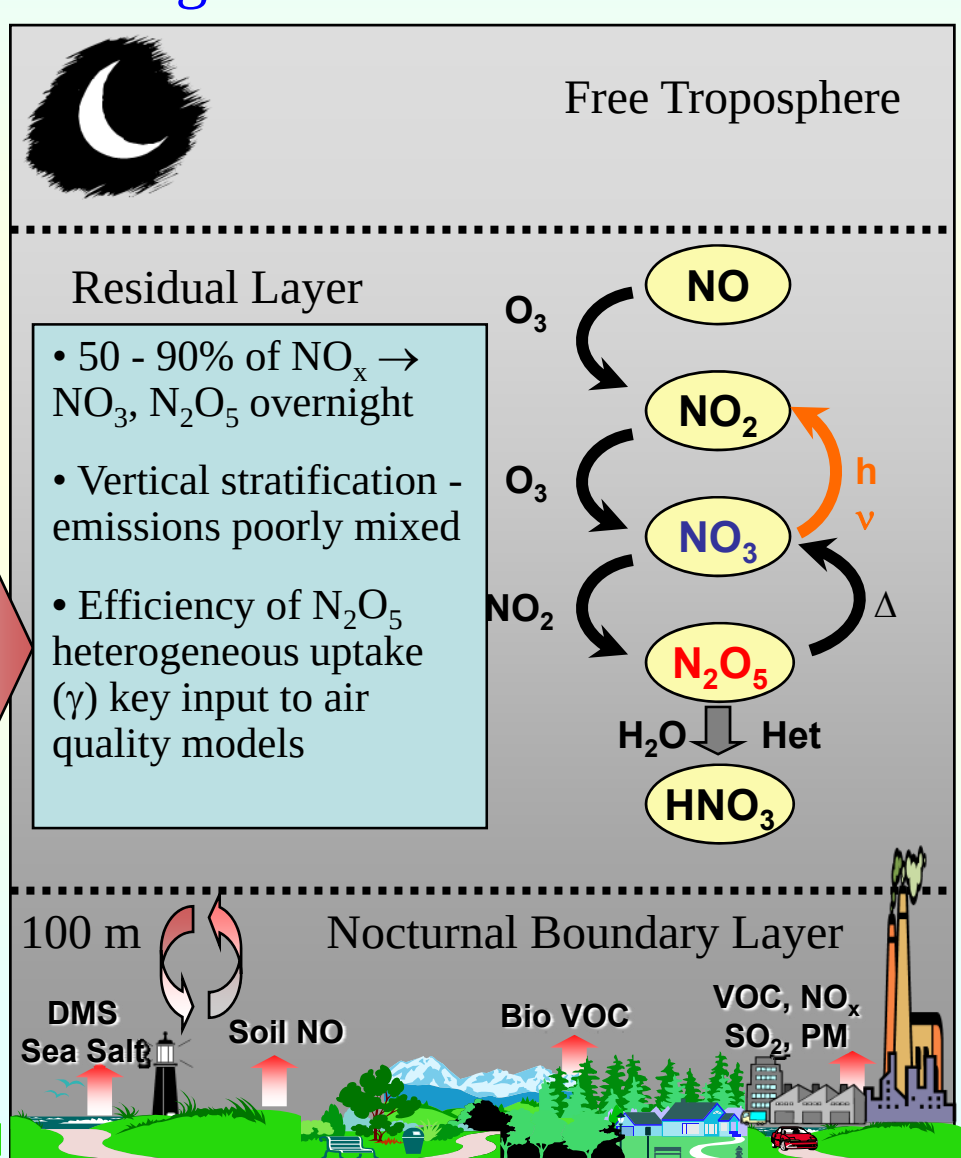
Chemical Transformation

Aim to understand on a process level for predictive capability

Nighttime Nitrate Formation





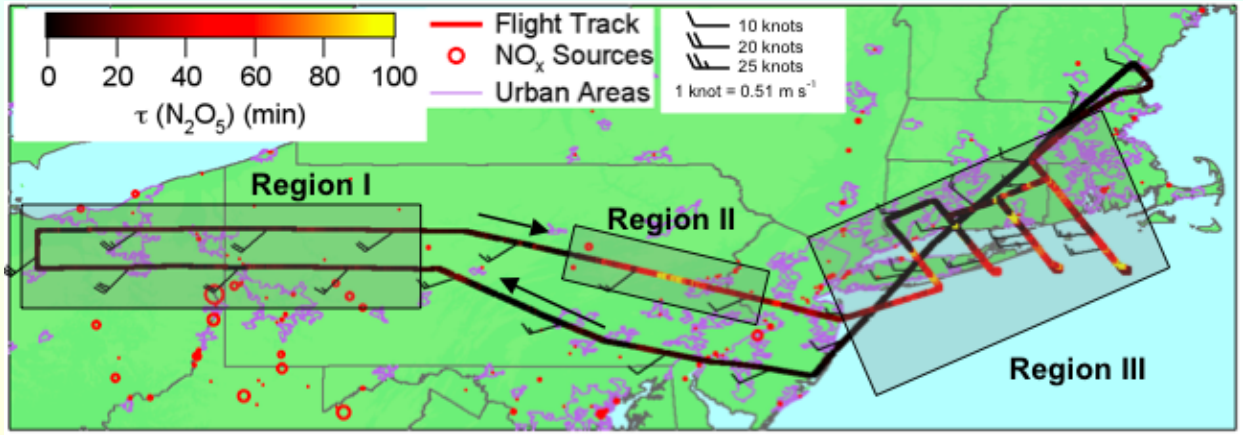
Chemical Transformation

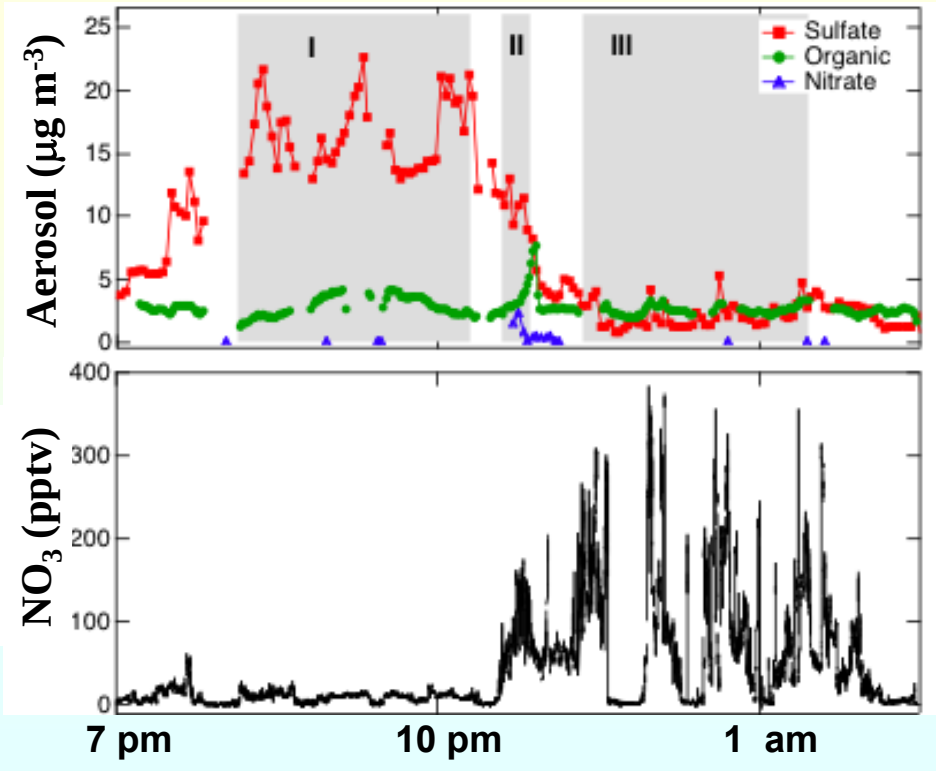
Aim to understand on a process level for predictive capability

Nighttime Nitrate Formation

In Eastern U.S. acidic sulfate aerosol enhances N_2O_5 nitrate formation in power plant regions.

In urban areas less acidic aerosol slows N_2O_5 nitrate formation - NO_3, N_2O_5 reservoir is available as NOx for the next day's photochemistry.





2010: How does California compare:

Small sulfate aerosol contribution, large organic aerosol fraction - Do these affect nitrate formation?

Large nitrate aerosol fraction - Does this inhibit N_2O_5 conversion?

Brown et al., 2006

Transport and Meteorology

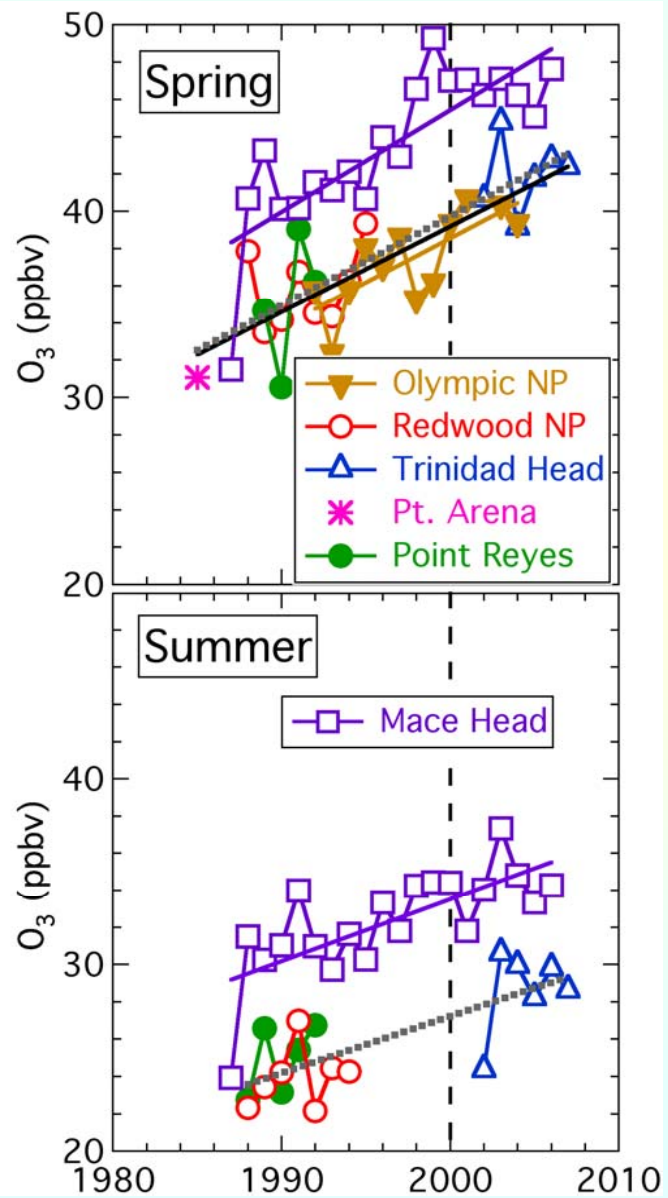
Understanding is critical for characterizing O_3 and PM levels

Transport of Asian emissions to California

Emissions of ozone and aerosol precursors from East Asia have increased rapidly over the past 2 decades.

Ozone concentrations in air arriving at the US west coast form the Pacific have increased substantially over the past 2 decades.

Due to increasing Asian emissions? Ozone concentrations have also increased in Ireland.



2010:

- **Does trend continue?**
- **Can we discern signature of cause of this increase?**

Parrish et al., 2008

Aerosol Properties and Radiative Effects

Aim to reduce uncertainty of aerosol radiative forcing

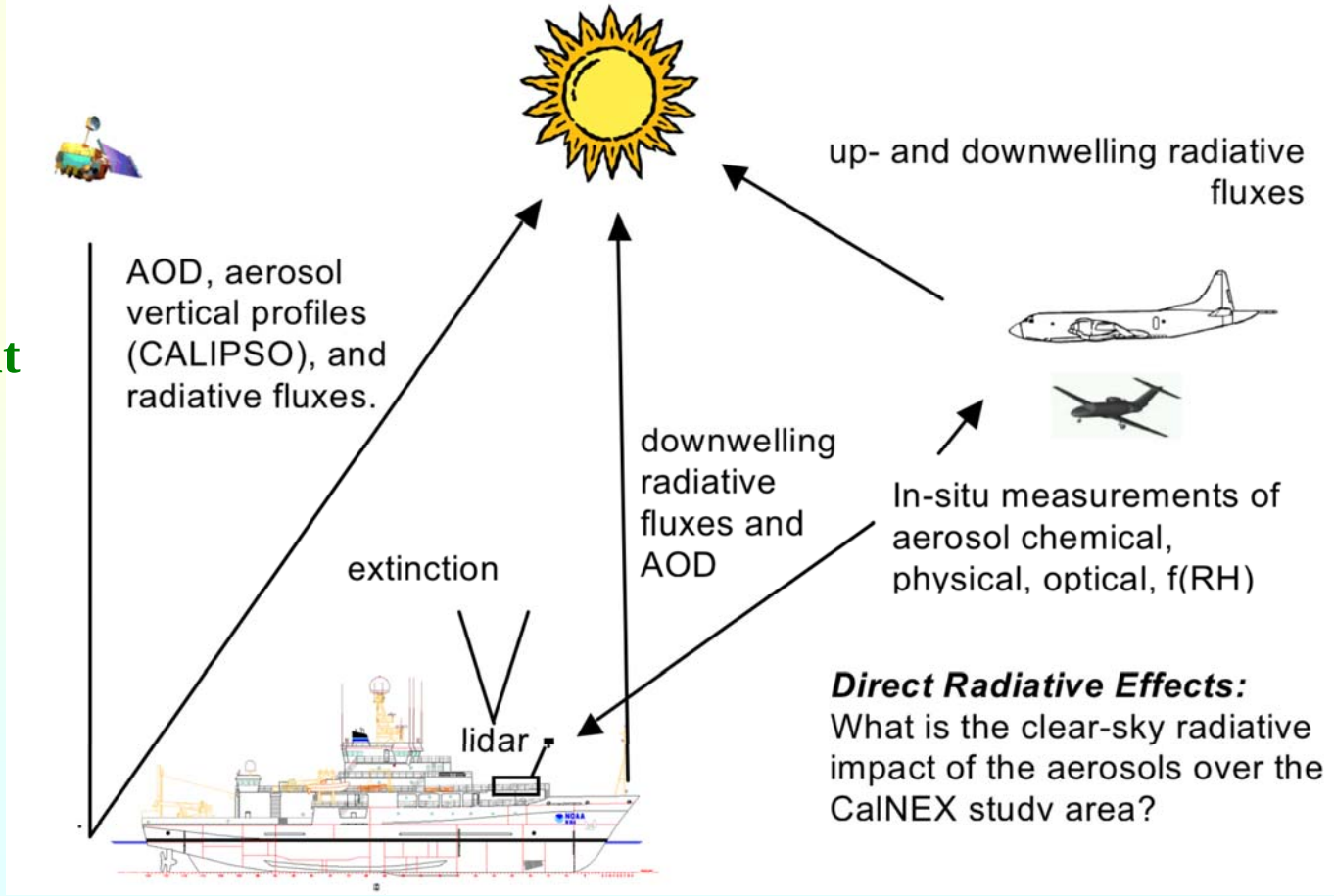
Direct Radiative Effects

2010:

1. Compare directly measured aerosol radiative properties with those calculated from the measured size distributions and chemical composition.

2. Measure and calculate clear sky radiative forcing under a variety of conditions:

- **downwind of different sources**
- **various altitudes and distances inland**
- **different times of day**
- **different meteorological conditions**



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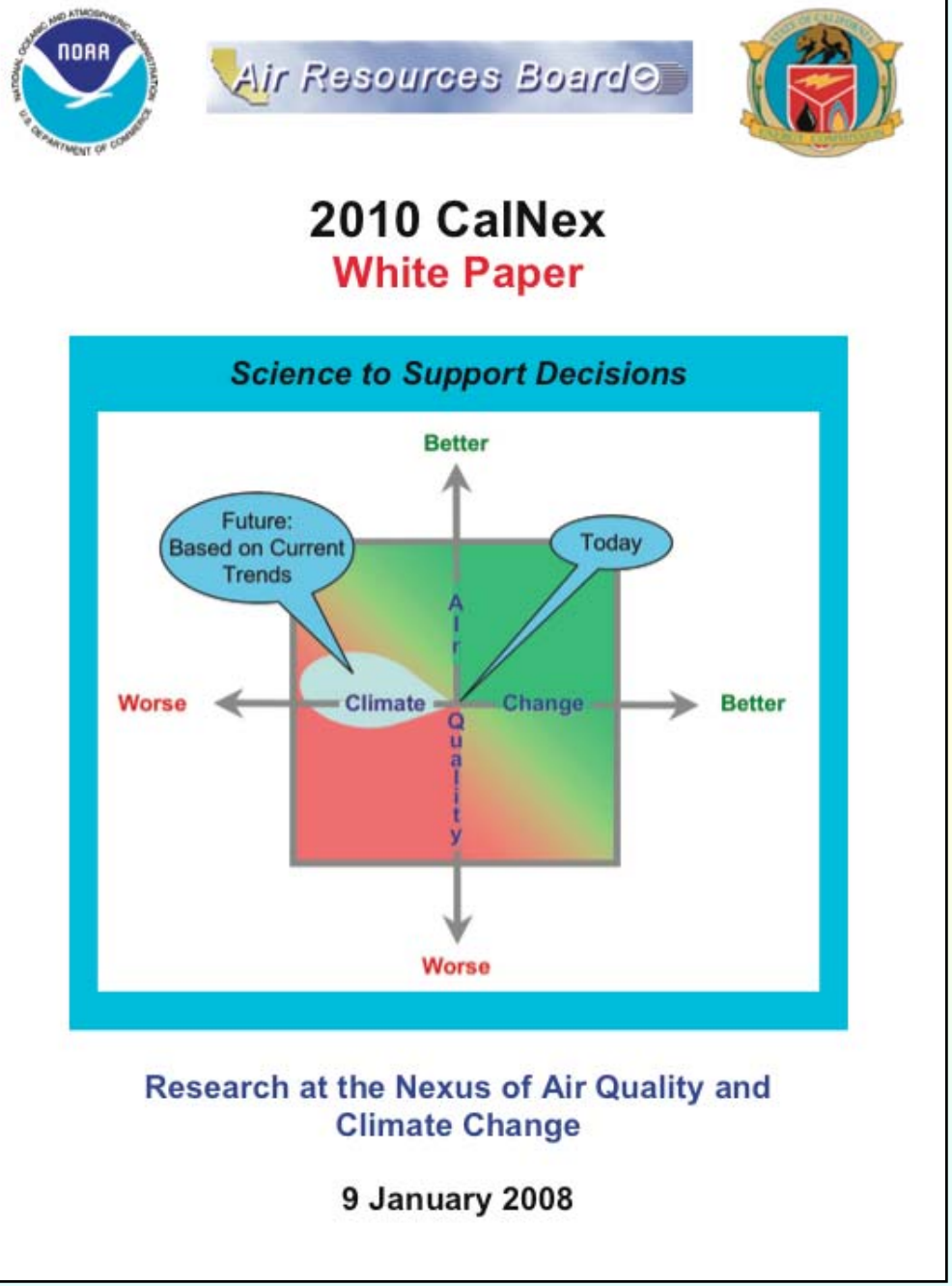

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